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A Review on Urban Resilience Assessment Methods

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Abstract: The world is currently undergoing an intense urbanization process. The percentage of urban dwellers has never been so high. In 2010, and for the first time, urban population surpassed the rural one, accounting for 51% of global population, and this trend will continue in the forthcoming years. This increment in concentration of population and supporting assets in cities, make their performance a critical issue for world population. Recent events such as Fukushima tsunami and the hurricane Katrina have shown how fragile built environments are and the unpredictability of occurrence and magnitude of the hazards. Such an expansion of the world's urban population, together with an increase in severity and number of hazards and catastrophes, has put under the spotlight the necessity to build cities not only sustainable, but resilient. Decision makers should acknowledge failure as an option, and the importance of developing city resilience. This paper will provide an initial review on urban resilience, definitions and assessment approaches as a first step for decision makers to account for resilience in their decision making process.

Keywords: Resilience, Sustainability, Resilient Cities, Urban Planning, Disaster Management.

I. INTRODUCTION

The concept of resilience in cities has been gaining increasing popularity in the academia in recent years, becoming a hot and robust research area in fields such as computer science, economics or environmental science [1]. This boom in resilience research has come with a diversity of different definitions for a concept that is not clearly grounded yet. The amalgam of related concepts such as vulnerability, fragility, resistance, rapidity, recovery, mitigation, prevention, flexibility or adaptability, that are often used interchangeably also contribute to the lack of standardization [2]. This lack of homogeneity in the concept is something still to be addressed and has played against the clarity of the term and the efforts made to measure it

When talking about urban resilience against natural hazards, built infrastructure plays a key role in achieving it, not only from a health and safety perspective, but from a service providing perspective. People chose to live in cities mainly because they offer the advantages of economies of scale and agglomeration. The sheer mass of people living in cities is what makes economically possible a series infrastructure, that offer crucial services for its population. These critical infrastructures provide urban population easy access to goods and services such as roads, lifelines, healthcare facilities, and so on. Important services that otherwise would not be as easily or economically available, and which absence can seriously compromise the welfare of the city. Therefore, the performance of critical infrastructures is of paramount importance to proper functioning of a city, and so it is their resilience to achieve city, or even country resilience (The United States Department of Homeland Security and the European Union, both acknowledge the importance of this assets and have programs in place to evaluate and improve the resilience of their critical infrastructure).

Cities require a wide number of sub-systems critical for their proper function, such as: transportation, education, health, electricity, water, culture, food, etc., therefore achieving an accurate urban resilience assessment is a daunting task. Moreover, if we consider resilience as a multidimensional attribute, each of these systems will have different measures for their different characteristics (technical, organizational, social, and economic) even several for each ones per dimension [3]. As urban systems grow in interconnectedness, the cascading and scalability of failures as they jump from one system to another is more and more probable, making each subsystems performance impact each other's [4],[5],[6]. Besides, there is a completely different group of "soft infrastructure" such as firefighting, healthcare, education, and community groups, among others [7], which are equally important for city resilience. Seems that no empirical indicator on its own can capture an accurate measure for resilience, and we should be looking to a set of them [8].

II. ASSESSING RESILIENCE

Resilience renders to be a complex, multidimensional attribute. This, together with the complexity of cities and the difficulty to assess city performance, renders the problem of assessing city resilience even more daunting. Some of the questions that have to be answered before being able to assess resilience are:
Which risks? What scale? What time frame do we con-

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sider? Do we account for inter-city relations? How do we rate city performance? What are the thresholds for these performance measures?

All this variables make the task of measuring city resilience virtually impossible. Several attempts have been made in the field of resilience engineering to quantify resilience of diverse systems, especially in the field of infrastructure and disaster resilience [9]. However, little holistic approach has been carried out so far at a urban level. Cities are more than a collection of built stock and lifelines and a more comprehensive approach is required [10]. The question is how do we link infrastructure and social resilience to achieve an overall city resilience metric?

III. RESEARCH FRAMEWORK

- Literature review

The research will commence with an in depth literature review. Covering areas such as resilience construct, resilience engineering, resilience frameworks and city planning issues.

- Preliminary Assessment Framework

From the previous resilience indexes, we will gather a list of indicators that are supposed to affect resilience as well as will try to include new indicators. A panel of experts in different areas (academia, industry, and if possible government) from the International Council for Research and Innovation in Building and Construction (CIB), will be consulted for qualitative analyses of the shortlisted indicators.

- Value Weighting

Weights will be assigned according to their relative importance within the overall city resilience. Analytical Hierarchy Process (AHP) will be used involving the pool of experts for this purpose.

Taking into account the singularity of cities' structure decision makers are invited to assign a second weight factor, given that they are in the best position to assign tailored risk assessments for their particular city for each indicator.

- Report

If possible, the framework will be applied into a case study and a report will be written analyzing shortfalls and limitations. In addition, further research paths will be proposed.

IV. EXPECTED OUTCOME

The aim of this research is to provide a framework for decision makers to assess their city resilience, as a first step to improve it. Identify resilience conferring characteristics of urban systems and sub-systems, and their contribution to overall urban resilience. The specific objectives for the research include:

1. Identify critical systems for the city performance.
2. Identify key characteristics that can confer resilience to these systems at different levels (technical, organizational, economical…).
3. Identify key metrics to measure systems performance attaining to serviced systems' needs.
4. Identify a list of "socio-economic" factors that can affect resilience in the event of a catastrophe.
5. Benchmark these characteristics and elaborate a resilience assessment framework and metric.

V. RESEARCH LIMITATIONS

This research will only focus on natural hazards. This does not mean many parts of it can be extrapolated to analyze threats of different nature. Infrastructure interdependencies and loops will be ruled out of the process. The current framework is intended to be applied at a city level, though it can be up or down scaled.

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